

APPENDIX E
EVALUATION OF DATA ACQUISITION SYSTEM USING A SIGNAL
WAVEFORM GENERATOR

1. REFERENCES

- A. MGA Research Corporation, **Operator's Manual for Waveform Generator Model RPG-6236-A**, (U. S. Department of Transportation, National Highway Traffic Safety Administration, February 1988)
- B. **NHTSA Data Tape Reference Guide - Volume I, Vehicle Crash Tests**, (U.S. Department of Transportation, National Highway Traffic Safety Administration, August 1985)
- C. Attachment 1 - **Data Tape Header Codes For Tests Using The SWG**.
- D. **SAE J211/1 MAR95 - Instrumentation for Impact Test**

2. DEFINITIONS

ATD	Anthropomorphic Test Device
Channel	Entire data path from sensor output interface, through the signal conditioner, the umbilical cable, and the DAS, to the digital data recorded on magnetic tape
Contractor	Owner(s) and operating personnel of the vehicle crash test facility
DAS	Data Acquisition System
DOT	United States Department of Transportation
NHTSA	National Highway Traffic Safety Administration
SWG	Signal Waveform Generator
TTM	Task Technical Monitor

3. OBJECTIVE

The purpose of this task is to evaluate all of the data acquisition channels used for recording signals in vehicle crash and sled tests conducted at contractor test facilities for the U.S. Department of Transportation, including signals from ATD and vehicle sensors. The primary and redundant channels used for the sensors are to be evaluated by injecting standard signals from a SWG furnished by the government into the sensor input interface of each channel and recording these signals on magnetic tape will be analyzed by government personnel at a government facility.

3. OBJECTIVEContinued

The evaluation testing shall be performed as directed by NHTSA. It is intended that the testing be performed every six months or at the beginning and the end of a test program, at the contractor's test facilities, normally before a series of tests that are scheduled to be conducted (See Section 6). The evaluation testing shall also be performed on an as needed basis if a question regarding the performance of the DAS at the contractor's facilities arises during a series or part of a series of scheduled tests.

4. GOVERNMENT FURNISHED EQUIPMENT

One SWG, with three cable connectors that mate with the output jacks of the SWG, and one copy of Reference A, will be furnished to the Contractor.

5. ITEMS OF WORK

5.1 PREPARATION FOR TESTING

5.1.1 SHIPPING

After unpacking the SWG and inspecting the instrument for possible shipping damage, the SWG shipping container and its foam packing should be retained in dry storage for future shipping use. When the SWG is next shipped, the Contractor shall be responsible for packing and shipping the SWG so that likelihood of damage in shipment is minimized. To accomplish this, the SWG shall be repacked in air bubble plastic wrap and polystyrene packing peanuts as it was when shipped to the contractor. Outer package labels shall specify correct orientation, "FRAGILE", and "DO NOT DROP". The use of shipping damage indicators, such as "Drop(N)Tell", is required.

5.1.2 CABLE PREPARATION

After receiving the SWG, the Contractor shall assemble the cabling necessary to connect the SWG outputs to the sensor output/signal conditioner input interfaces. The Contractor shall supply the connectors that mate with the Contractor's signal conditioner inputs (or umbilical cable, as appropriate) and the wire or cable necessary to transmit signals from the SWG to the signal conditioner inputs. The Contractor shall verify that the SWG input power marking is appropriate for the available local power.

5.1.3 SWG PERFORMANCE CHECK-OUT

The Contractor shall check-out the SWG performance by displaying each waveform and time reference output on a storage oscilloscope (of which the amplitude display has been calibrated to $\pm 3\%$) and comparing the displayed waveform with Figure 5-1 in Reference A. If significant differences such as loss of signal output from one or more channels, differences between positive and negative amplitude peaks greater than $\pm 5\%$, or irregularities where straight lines are shown in Figure 5-1 are observed, the Contractor shall call the TTM.

5. ITEMS OF WORK...Continued

The Contractor shall notify the TTM of the test schedule at least two weeks prior to start of test in case the Government desires to witness the test.

5.2 TESTING

5.2.1 OPERATING ENVIRONMENT

The SWG shall not be operated outside the environmental limits of -10°C to 50°C and relative humidity of 0% to 94%. The SWG shall not be in contact with water, ice, or snow.

5.2.2 SWG to DAS CONNECTIONS

The ± 100 mV output level ("piezo resistive" setting) signals from the SWG shall be connected to the facility instrumentation and DAS so that these signals pass through both the signal conditioning electronics and the crash or sled test umbilical cable, in the same sequence as is used in vehicle crash or sled testing. If the signal conditioners on any channel are designed to handle only lower level signals, resistive shunts shall be installed at the instrumentation interface to reduce the SWG signal voltage level to the full input range of the channel under test. The SWG output impedance is 348 Ohms.

In cases where the signals from two or more channels are combined during later processing, such as driver head x, y, and z accelerations, the channels used to collect these data shall be tested simultaneously. The channel used for the x-axis signal shall receive a "Group 1 waveform" input (SWG channels 1, 2, 3, 4, 9, 10, 11, and 12). The channel used for the z-axis signal shall receive a "Group 2 waveform" input (SWG channels 5, 6, 7, 8, 13, 14, 15, and 16). The channel used for the y-axis signal may be tested with either waveform input.

Each time waveform data is recorded, one channel of time synchronization data shall be recorded. The channel used for the time synchronization data shall be capable of accepting and recording a "TTL" pulse (0 to +5V), 10 milliseconds wide. It is expected that this would be the channel or channels used by the Contractor to record "time zero" signals during vehicle crash and sled testing.

The Contractor shall set up to test as many channels simultaneously as is practical, up to the limit of 16 set by the SWG. The Contractor shall record the identity of each DAS input channel connected to each SWG output channel.

5.2.3 SIGNAL CONDITIONERS

For each data channel to be tested, the signal conditioner used with that channel for crash or sled testing shall be set up. Setup and calibration of each signal conditioner shall be performed exactly as is done for a DOT contracted vehicle crash or sled test in accordance with SAE J211/1 MAR95 - Instrumentation for Impact Test (Reference D).

5. ITEMS OF WORK....Continued

5.2.4 SWG POWER

The SWG furnished for use in the United States is wired to accept 120 VAC 60 Hz electrical power. The acceptable tolerances on 120 volt input power are 120 VAC, +10%, -13%, and frequency variation from 47Hz to 63 Hz. The SWG furnished for use in Europe is wired to accept 230 VAC, 50 Hz electrical power. The acceptable tolerances on 230 volt input power are 230 VAC, +15%, -10%, and frequency variation from 47 to 63 Hz. Each SWG will be marked with a label, located over the AC power input connector, that identifies the input power setting for that unit. For use with input voltage levels outside the marked range, the SWG power input transformer must be re-connected in accordance with Appendix B of Reference A.

The contractor shall apply power to SWG, signal conditioners, and DAS; and allow the SWG self-test to complete as described in Section 3 of Reference A. If a failure is indicated, the Contractor shall call the TTM.

5.2.5 TEST

The Contractor shall start the DAS recording mechanism, press and release the "RECORD" switch, and one-half to one second after the "RECORDING" light turns "OFF", press the calibration switch for approximately one-half second or more. If it is not possible to record waveform data and calibration data in the sequence described in the previous sentence, the calibration data and the waveform data shall be recorded in as close time proximity as possible by the facility. If more than five minutes separates recording of the waveforms and calibration signals, please contact the TTM.

The Contractor shall repeat steps 5.2.2 through 5.2.5 until all data acquisition channels have been tested. After each test run, the Contractor shall check the recorded data for anomalies, to assure that valid waveform data has been recorded for each channel.

The Contractor shall record SWG ambient temperature at the start and at the end of testing.

5.3 DATA TAPE REQUIREMENTS

The Contractor shall provide the digitized data on a magnetic tape written in the format specified for vehicle crash test data in References B and C. Digitizing of the data that has been recorded on analog magnetic tape shall be performed in exactly the same manner as in a DOT contracted vehicle crash or sled test. If it is possible, the digitizing process shall be initiated by the "pretime zero" pulse in the SWG time synchronization output.

During each run when waveform data are digitized, the corresponding SWG time synchronization output shall also be digitized. This time channel shall be the first in the sequence of channels to be digitized. Channels of signals that will be

5. ITEMS OF WORK....Continued

combined during later processing, such as driver head x, y, and z accelerations, shall be digitized during the same run. The digital data files corresponding to the time synchronization channel and each of the waveform channels shall be identified. Waveform outputs shall be scaled so that \pm full scale corresponds to ± 200 .

In creating the data tape, the Contractor shall provide the information required for the GENERAL TEST INFORMATION and the INSTRUMENTATION INFORMATION tape headers. The exceptions to the header code assignments of Reference B, given in Reference C, shall govern.

5.4 REPORT

A letter report on the DAS testing performed under this TTD shall be prepared. The report for this test shall include the date and time of the test, the names of the test performers and the responsible supervisor, the environmental conditions during the test a complete description of the test set-up, including a list identifying each SWG output channel connected to each DAS input channel, and a list of equipment used in the data acquisition channels tested (e.g. signal conditioners, filters, digitizing hardware).

The report shall also include plots of data from all channels tested, a description of anything that occurred during the test that might affect the data or the results of the test, and a description of any data processing algorithms (such as zero offset removal, detrending, scaling) used on the data from the digitizing through to the final recording process.

6. DELIVERABLES AND SCHEDULE

All deliverables shall be delivered to:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Mail Code: NRD-11
400 Seventh Street, S.W.
Washington, DC 20590
Attn: Ms. Randa Radwan Samaha

A. Evaluation test completion:

As directed by NHTSA

B. Digital data tape written in NHTSA vehicle crash test format:

within 1 week after the evaluation test.

C. Test report:

Three copies of final report two weeks after the evaluation test.

Attachment:

DATA TAPE HEADER CODES FOR TESTS USING THE SWG

NOTE: Where any of these header code assignments differ from those presented in Reference B, the assignments of this attachment shall govern.

VERSION NO. S2

TSTREF DDMMYYxxxx

DDMMYY Test date where - -

DD - - 2 digit day

MM - -2 digit month

YY - - 2 digit year

xxxx - 4 characters for contractor's reference use

TSTTYP SWG Signal Waveform Generator test of the DAS

CURNO 001 Channel 1 of DAS
002 Channel 2 of DAS
nnn Channel nnn of DAS

SENTYP LL Low level signal (Strain gage)
HL High level signal (Piezoresistive)
ET Event time indicator (Code already exists)

SENLOC 01 Driver side (Code already exists)
02 Passenger side (Code already exists)

SENATT The four character code for SENATT from Reference B that designates the location of the sensor to which the channel under test would normally be connected. When a sensor is not assigned to the channel under test, the SWG channel connected to this channel shall be identified here using the code shown under INSCOM (below).

AXIS XL Sensitive axis of sensor that would be connected to DAS channel under test is X axis.

YL Sensitive axis of sensor that would be connected to DAS channel under test is Y axis.

ZL Sensitive axis of sensor that would be connected to DAS channel under test is Z axis.

INSMAN Serial number of SWG used for the test

DATA TAPE HEADER CODES FOR TESTS USING THE SWG....Continued

CALDAT Last calibration date for instrumentation used in data acquisition channel tested.

INSCOM Commentary field. The Contractor shall identify the SWG channel connected to the DAS channel under test. The code listed below may be used to identify the SWG channel. In addition, such information as run number, amplifier, tape recorder, tape recorder channel, or anything else required to uniquely identify the DAS channel equipment shall be included. There are only 70 characters available. Do the best that you can!

SWG01	Channel 1 of signal waveform generator
SWG02	Channel 2 of signal waveform generator
SWG16	Channel 16 of signal waveform generator
SWGH1	High level signal of Group 1 waveform
SWGH2	High level signal of Group 2 waveform
SWGE1	Event time indicator (Time zero)
SWGE2	Event time indicator (Delayed time zero)
SWG11	Event time indicator (Inverted time zero)
SWG12	Event time indicator (Inverted delayed time zero)